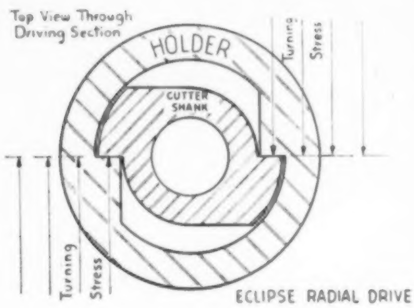
ASTE

JOURNAL

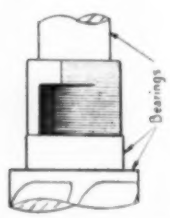
JANUARY, 1934

Announcing

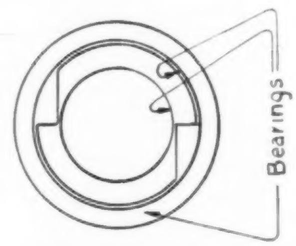
Eclipse SUPER STRENGTH RADIAL DRIVE COUNTERBORE



The two driving faces are arranged exactly on a line through the common center of holder and cutter shank and only a radial or turning action can result when the tool is in operation. This minimizes torque and eliminates wedging or splitting open of the holder common to many double drive systems.



Adopt the Eclipse Super-Radial Drive on your production counterboring, core drilling and multidiameter boring operations and be assured of the resultant accuracy and lowering of tool costs.



The cutter shank driven faces are integral, being formed into the solid shanks. Two accurately ground cylindrical bearing surfaces, one above and below the drive lugs, and a ground thrust bearing maintain concentricity of the asembled tool.

The double drive mechanism in the holder is also integral, being machined from the solid, hardened and ground throughout. A simple lateral internal lock retains the cutter in positive driving position eliminating vibration and maintaining constant thrust.

Radial Drive interchangeable counterbores, countersinks, and multi-diameter boring cutters are supplied in all standard and special sizes from 3/4" to 4 1/2" diameter on prompt delivery. Our Engineering Department will submit designs and recommendations for special tools upon receipt of your part print and sketch of proposed tool lineup.

Direct Factory Representatives in all Industrial Centers

ECLIPSE COUNTERBORE COMPAN

DETROIT 7410-30 ST. AUBIN AVE MICHIGA

Secretary
MAdison 2057

Editor
MAdison 8422

A. S. T. E. Journal

Published by the American Society of Tool Engineers
8316 Woodward Avenue
Detroit, Michigan

William H. Smila, President
Frank Hartlep, First Vice-President
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Published for Members Only

VOL. II JANUARY No. 9

O. B. JONES, Editor

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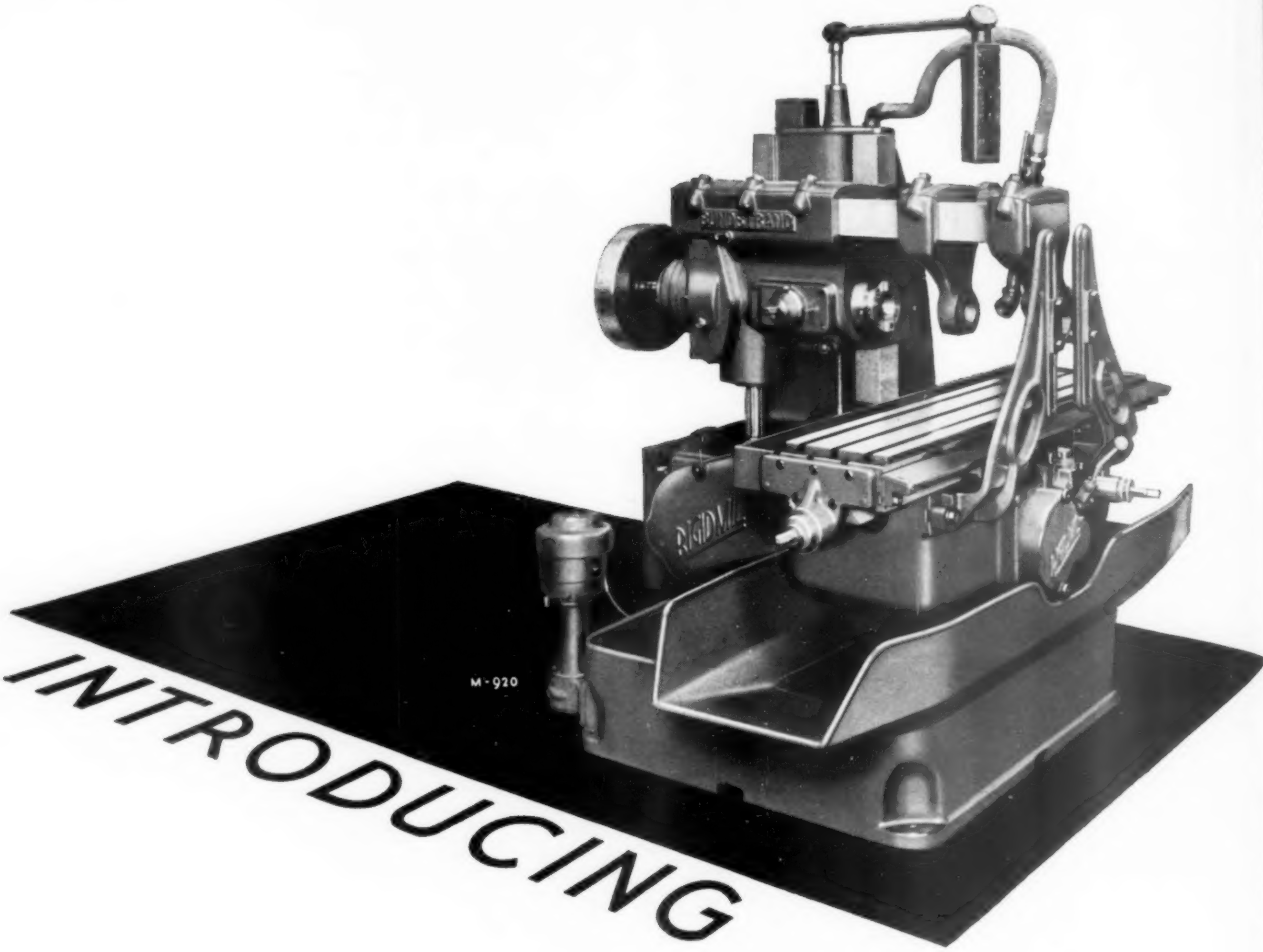

the Sundstrand 3-A RIGIDMIL

SUNDSTRAND MACHINE TOOL CO.
S
ROCKFORD, ILLINOIS, U.S.A.

Wider horizons; greater possibilities for cutting costs, improving production, increasing net profits; are provided by the new Sundstrand 3-A Rigidmil shown above. This machine has all the basic Rigidmil principles pioneered by Sundstrand, plus a large number of important improvements, including quick change speeds and feeds if desired. Thirty of these features and advantages are indicated in a new circular which will be sent promptly on request. It is true that no Sundstrand Rigidmil is obsolete or worn out but, if you are going to buy new milling equipment this year, surely you will want to learn all about the new 3-A Rigidmil. Suggestion—*Do it now.*

Nos. 3-C and 4 Rigidmils, for larger work, soon to be announced.

Lathes
Milling Machines
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NEW CENTER BUILDING - DETROIT, MICHIGAN - Phone Madison 3660

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OUR PRESIDENT'S MESSAGE

WILLIAM H. SMILA

OUR MEMBERSHIP COMMITTEE

ONE of the most important committees of the A.S.T.E. is the membership committee. Upon the original membership committee fell the duty of establishing our application blank form as well as registering all charter members, and checking their applications to see that they were properly filled out. This required considerable work by the entire committee and I, as chairman of the original committee will say that every member worked to the best of his ability.

After the charter members were properly registered and approved by the board of directors the membership committee started to receive applications from prospective members. Each application as received is forwarded to the Secretary's Office where it is "checked in" and referred to the membership committee. The membership committee then check the application to determine if the aplpicant is qualified for membership and in case of doubt it becomes necessary to check the references. After it has been determined that the applicant is qualified for membership he is then classified either as a junior or senior member depending upon his age and experience.

Many applicants wonder why so much time is consumed between the time of presenting their application and the time of receiving their membership card. This is readily explained by the fact that the directors hold regularly quarterly meetings and that each application is balloted upon by the directorate, hence there is a possibility of an applicant waiting three months, provided his application is properly filled out and even six months if it becomes necessary to return an application for further information, signature or replies to references, and so on.

During the last quarter of 1932 the membership committee put on a membership drive. This was conducted by segregating our membership into ten groups and appointing a team captain in charge of eaech group. Mr. Fred L. Hoffman's team was the winner of this drive with Mr. Wm. Peterson's team running a close second. Our membership was greatly increased during this drive and so as a climax to the drive the winning team was banqueted.

At the installation of officers in April 1933, Mr. Fred Hoffman was appointed chairman of the new membership committee, but owing to his many other duties he was forced to resign and Mr. Wm. J. Fors was appointed in his place. Mr. Fors proceeded to appoint the members of his committee and we now have an excellent committee and are expecting some very good results from this committee. Plans are now under way for the development of a chapter at Flint, Michigan and the chartering of this chapter will cause considerable effort to be put forth by this committee.

The membership committee is responsible for keeping the old members in the society as well as obtaining new members and each and every member can help by promptly paying his dues and by soliciting the application of an eligible prospect.

We are now starting the New Year and I believe with the proper cooperation on the part of our members there is no reason why our membership should not reach one thousand before the end of the year. With this as our goal, let us proceed.

NEWS OF INDUSTRY

E. R. DeLUIZ

New Process to Cut Time of Annealing.

Ann Arbor, Michigan. Annealing of malleable iron, used in automobile brake pedals and other parts, has been reduced from a six-day process to two days, the University of Michigan engineering research department has announced. The process, it is estimated, will result in a substantial savings to industries doing a normal annual business of $100,000,000.

In the regular process, iron parts are stacked in a furnace and packed with inert material to keep the oxygen in the fire from scaling the iron. The packing, heating, cooling and unpacking require a week or more. The new process eliminates the packing by heating in gas furnaces, controlled to eliminate the oxygen.

On Night Shift.

Lansing, Michigan. Federal Drop Forge is operating three hammers on a day and night shift, M. P. Carrier, president and general manager, has announced. New automobile business is accounting for the overtime.

De Soto Gains Continue Into Current Month.

Detroit, Michigan. Total new car deliveries of DeSoto and Plymouth motor cars by DeSoto dealers for the week ended December 2nd, were 1420 units, an increase of 8 per cent over the previous week, it was announced by L. G. Peed, DeSoto general sales manager. This was an increase of 44 per cent over the same week of last year.

Plymouth Fetes Employes at Factory Carnival.

Detroit, Michigan. More than 15,000 employes of the Plymouth Motor Corporation, their families and friends, attended the fall keno party and country carnival given at the Plymouth factory in Detroit recently. Given by the employes for the benefit of the welfare and recreational funds, this affair was said to be highly successful.

1934 Hudson Terraplanes Off.

Detroit, Michigan. That Hudson is off to a flying start for 1934 is the verdict returned since last week's meeting of some 300 Terraplane and Hudson distributors who spent three days at the factory inspecting the new models.

As a result of the orders placed at this session, production will start next week at a hot pace, and indications point to next month being the biggest production January in the past three years. By Chicago show time it is expected that 12,000 new Terraplanes and Hudsons will have come off the assembly line, according to W. R. Tracy, sales manager. By that time it is expected that Hudson will be under full steam and the prediction for February is a production of 12,000.

"See page 6 for important next meeting announcement."

NEXT MEETING

DINNER

MAIN BALL ROOM **DETROIT-LELAND HOTEL**

THURSDAY, JANUARY 11

6:30 P. M.

Procure tickets from Meetings Committee or at Ball Room Door

TECHNICAL SESSION—8 P. M.

THE DEVELOPMENT OF PRECISION BORING

By **A. W. SCHNEIDER***

WE have had a previous meeting devoted to the important subject of Boring but at this meeting we shall be privileged to glean more information on one of the most important processes employed in the manufacturing of high-speed motors-which are the vogue today in automotive manufacture.

The able speaker, M. Schneider has been connected with the machine-tool industry almost continuously since 1915. He is graduated from the University of Cincinnati with the degree of Mechanical Engineer. Since graduation he has been associated at various times with the Cincinnati Milling Machine Company, The Cincinnati Shaper Company and previous to his present connection with the Heald Machine Company was Works Manager of the Reid Prentice Corporation.

His talk will be illustrated with lantern slides and should prove to be one of the most interesting and educational narratives we tool engineers have had the pleasure of hearing.

*Manager, Borematic Division, Heald Machine Company

At our February meeting, Mr. C. E. Johansson, world famous as the manufacturer of precision gage blocks, will be the key-note speaker.

A. W. SCHNEIDER

DECEMBER MEETING

THE December meeting of the Society was held at the Detroit-Leland Hotel, December 14th. Much interest was shown in the several displays of gages which were assembled for the inspection of the members. The displays showed the products of several manufacturers as follows: the Federal Products Corporation showed their line of indicators and fixtures with their district manager, Mr. C. G. Gilbert officiating. The Sheffield Tool and Machine Company displayed their line of gages with their president, Mr. Reynolds in charge. The Pratt & Whitney's display was demonstrated by their district representative, Mr. Wilbraham and his staff. The Taft-Pierce Manufacturing Company showed their line of plug and snap gages with their Detroit representative, Mr. Higgins in to describe them. The B. C. Ames Company had their line of indicators on display in charge of their representative, Mr. Haggerty, and The Swedish Gage Company of America showed their line of gage blocks and snap gages with their sales manager, Mr. B. A. Johnson in charge.

The meeting was called to order at 8:30 by President Smila. Secretary Sargent described the progress being made in organizing the Flint chapter and stated that reports indicated that their full quota would be reached before the next regular meeting.

Oviatt Talks on Gages

The first general meeting of the American Society of Tool Engineers was held at Webster Hall nearly two years ago. Mr. David Oviatt was the speaker at that meeting. He was connected with the Buick organization at that time and was chairman of the General Motors Standards Committee. The subject of his talk at that time was "Standardization of Tools and Gages."

Mr. Oviatt is now a member of the Dodge division of the Chrysler Corporation and spoke at the December meeting on the "Design, History, and Standardization of Gages." The work Mr. Oviatt has done in the standardization of tools and gages makes him thoroughly familiar with the subject, making it a great pleasure to hear him.

Going back into the history of gages he described the first standard tolerance for holes and shafts. The basic diameter was established as the minimum hole. This was called the "Uni-lateral" tolerance system. Later the "Bi-lateral" tolerance was developed to somewhat overcome the faults of the uni-lateral system. The bi-lateral tolerance fixed the hole size both above and below the basic size. This provided holes for fits all the way from running to press fits without deviating too far from basic with the shaft.

The next development was the "Uni-bi-lateral" tolerance, which provided for one-third of the tolerance above the basic size and two-thirds of the tolerance below the basic size. This system was developed more in consideration of reamer life than anything else.

After mass production and the manufacture of interchangeable parts became thoroughly established, the engineers approached the standardization of holes from another angle. At this time drills had been standardized with the basic diameter as maximum and bushing standards had been developed which were based on the drill sizes. Therefore they developed a set of tolerances based on present drill and bushing sizes which provided for reamers to be used in the bushings then available and give maximum wear based on the type of fit desired.

Standardization of gages was correlated with the standardization of drills, reamers, and tolerances so as to eliminate thousands of special sizes of tools and produce maximum tool life consistent with the fit required.

The talk led through the origin and history of gages as they developed along with the standardization of tools and tolerances. We regret that space prevents the reproduction of the entire talk in this issue.

NEW JIG SAW

The Vacuum Electric Corporation of Detroit, has recently introduced a new and useful vibratory saw. Using nature's second strongest force, magnetism, this saw moves at the un-heard-of speed of 7200 strokes per minute on a 60 cycle,

110 volt, alternating current. This high speed permits the use of fine blades and insures a very smooth finish with no sanding necessary. It cuts hardwood up to 1", soft metals, fibre, paper, or cardboard. This remarkable tool is a valuable addition to the work bench, and it is very practical for cabinet making or pattern making. For further particulars we refer you to their advertisment in this issue.

"BY PERMISSION OF THE COPYRIGHT OWNER"

The article "Idle Time" appearing in the December Journal was contributed by the McGraw—Hill Book Company from their excellent treatise "Motion and Time Study," by Allen H. Mogenson. Due to our error the article appeared without mention of the copyright owners or the author. We sincerely regret the error.

Our readers will recall reading a review of this book in a previous issue of the Journal.

PRIZE-WINNING IDEAS

PRIZE-WINNING IDEAS

Ideas of interest to Tool, Die, and Machine Designers, and Tool Engineers which pertain to the design of equipment used in mass manufacturing, or methods used in mass manufacturing, will be published in this space each month. A prize of $5.00 will be awarded the person contributing the idea selected as best by the judges. Non-members of the Society are also eligible. Ideas received prior to the 20th of the month will be published in the Journal of the following month. If drawings are required to clarify the idea, they must accompany the written description.

JUDGES

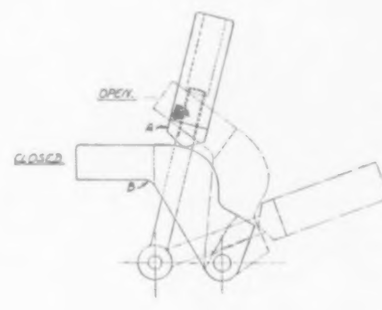
E. C. LEE, Chief Tool Designer, Jefferson Avenue Plant, Chrysler Corporation; W. F. WAGNER, Chief Tool Designer, Lincoln Motor Car Company; S. E. BERGSTROM, Detroit Representative, Cincinnati Milling Machine and Cincinnati Grinders, Inc.

A QUICK ACTING CLAMP

by **HENRY COOK**

(Tool and Machine Designer)

THE figure illustrates a clamp which is operated entirely by the knurled handle which presses the collar A against the upper cam face of the member B. The eyebolt passes through an elongated slot in the member B. The clamp is moved from its open position, as indicated by the dot-dash-



lines, to its closed position as the handle is raised, bringing the collar A into contact with the upper convex cam surface of the member B.

It is returned to its open position as the handle is lowered and the eye-bolt makes contact with the upper portion of the lower end of the slot.

This clamp finds its best application in cases where the part must not be scratched or marred.

CONGRATULATIONS TO THE F. JOS. LAMB COMPANY

The past few years have strikingly demonstrated that unusual business sagacity, backed by a first-class product, is required to bring any business through twenty years of successful operation. Such, however, is the record of the F. Jos. Lamb Company, and we are mighty glad to congratulate Mr. Lamb in having accomplished this remarkable feat.

Just what per cent of businesses survive 20 years is hard to determine, but it is certainly so small as to be almost microscopic and certainly very discouraging to anyone contemplating the launching of a business of his own.

It would be interesting to know just how many companies engaged in machine and tool building or designing in Detroit are eligible for registration on the honor roll of the "Two Decaders." Perhaps there are some who have equaled or broken this record. The Editor would appreciate hearing from those who have.

"See page 6 for important next meeting announcement."

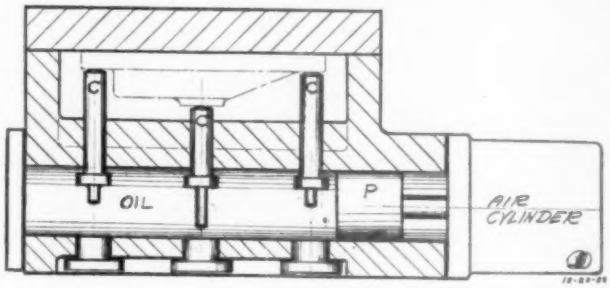
NEW TOOLS AND PROCESSES

B. L. DIAMOND HAROLD GILLER

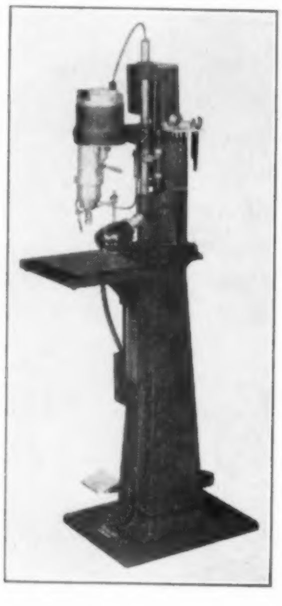
HYDRAULIC EQUALIZING PLUNGERS

THE illustration shown is of an arrangement for equalizing the pressure of each of several equalizing plungers C. The arrangement can also be used for varying the pressure at the different points due to the fact that the cross sectional area of each plunger shank can be varied. A plunger of twice the area will exert twice the pressure and vice versa.

Each plunger extends into a chamber of any desired shape. The chamber is filled with oil. A plunger, P, is forced into this chamber in any desired manner, that is, by a screw, a lever, rack and pinion, a weight, or an air cylinder. As this piston increases the pressure in the oil chamber and against the ends of the plungers C they are forced outward. When the piston is withdrawn a vacuum is created and the plungers are drawn down into the oil chamber. The stroke of the piston must be long enough to take care of the displacement of oil created by a movement of the plungers.



HASKINS HIGH SPEED TAPPING MACHINE



R. G. Haskins Company, 4636 West Fulton Street, Chicago, Illinois, U.S.A., presents a new high speed tapping machine with a self-contained head incorporating a sensitive reversing mechanism operating at high speed. The tap is held by a collet chuck that is small in diameter and weight to minimize the inertia effect. Sufficient number of collets are furnished to take taps from No. 2 to No. 14 inclusive.

The machine is regularly furnished with gears for any two of the following standard tapping speeds: 1500, 1750, 2333 and 3062 R. P. M. Special gears can be furnished for other speeds. The reverse speed is twice that of the tapping speed.

To provide lubrication for high-speed tapping an oil pump is provided. The amount of discharge of this pump is adjustable.

The motor is repulsion-induction, ball bearing, and is controlled by a start-stop switch conveniently located in the housing. The tapping unit including other vertical moving parts are counter balanced by a weight included within the machine frame which gives the machine a free floating sensitive action. An adjustable light attached to the frame furnishes ample illumination.

This machine can be furnished with pedestal or bench mounting. The tapping capacity is to 1/4" in brass and to 3/16" in steel. Finish is crystalline baked varnish, natural aluminum and nickel plate.

An apology to the HOUSE OF AUSTERBERRY

Only the editor knows of the hundreds of big and little mistakes which are weeded out of editorial and advertising copy as it is being prepared for publication,—but the whole danged world knows when the name of an institution as old and well known as the House of Austerberry slips past the proofreader with an "m" where the "u" should be.

When the American Society of Tool Engineers has been editing the Jounral as long as the House of Austerberry has been selling machinery,—well, such an error as we made in the December Journal of 1933 will be impossible.

TOOL ENGINEER STOPPED 12 HOURS

At about the time we go to press with this issue of the Journal, Mr. William V. Goodson of the American Equipment Company is preparing to board the good ship *Olympic* on his way back to Detroit with his family from Nottingham, England. Shortly after sailing from New York on the *Britannic* on the 14th of December he had the old-time experience of being stranded on a sandbar near Cape Cod for twelve hours—but nothing can stop a tool engineer for long . . . . when he's going on a vacation.

PRE-DETERMINING DIRECT LABOR COST

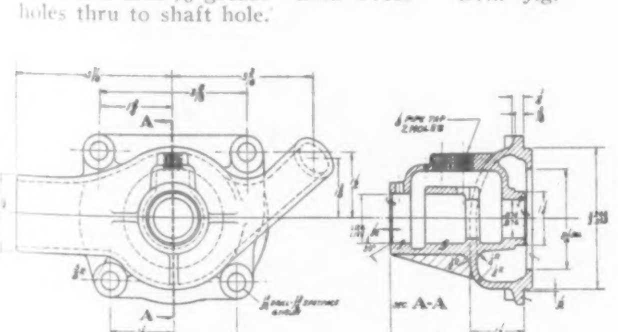
IT is only recently that an accurate pre-determined direct labor cost has been required of a manufacturing division by engineering and management. The old method was to design and tool a part and turn it over to production with the only requisite being an O. K. product from the machines. It then devolved upon the Time Study Dep't. to spend considerable time on the job, with the usual antagonistic attitude of operators, foremen and supervisors to combat, to speed up, eliminate or re-tool operations in order to maintain a proper cost level throughout the plant. This method is far too slow and expensive from all angles and is becoming rapidly obsolete, being superseded by pre-determined production cost established by skilled analysts using accumulated production data complied by themselves and by machine tool builders.

The following is an analysis of the operations and tooling of the Water Pump Body, illustrated and which is now being machined in a large automobile plant in Detroit:

The part is a grey iron casting of conventional present automobile water pump design. The pump must be free from leaks, necessitating a water test. The cylinder block joint face must be square with the axis of the shaft hole within .0015". The shaft hole is of two diameters with the larger diameter at the end opposite the cylinder block joint face.

The following tool lineup is obtained from the tool engineering department.

Operation	Machine	Type of Tools
1—Rough & finish face Cyl. joint face & turn pilot dia. & bore & ream small end of shaft hole.	New Britain 4 Spdle. Chucking Machine.	Air Chucks Carboloy tip tools.
2—Drill (4) flange holes.	#3 Avey Dr. P.(Power feed)	Pump Jig &(4) Spdle. head.
3—Bore and line ream both dias. of shaft hole and face small end. (locate from Cyl. joint face on face plate adaptor)	New Britain 4 Spdle. Chucking Machine.	Air Chucks Carboloy tip tools.
4—Water Test	Air Cylinder operated Bench Test Fixture	
5—Drill and tap (2) ⅛ pipe holes and drill ⅛ grease holes thru to shaft hole.	4 Spdle L&G Drill Press	Hinge type Drill Jig.



The analyst sets up an operation analysis on the part as follows:

Oper. No.	Minutes
1—Length of longest cut-2¾" Cutting time (intermittent facing cut-3" feed) incl. index	.85
Actual time consumed in chucking	.18
Time available to operator during cycle	.67
Gross actual prod. rate per hr. of machine	70 plus
% tool allowance	10%
Net Hourly Product 90% of gross	63
2—Loading Time	.09 min.
Drilling Time (¾" travel)	.30 min.
Unloading Time	.06 min.
Total time of operation	.45 min.
Actual time of operator	.15 min.
Gross rate of hourly product	133
% tool allowance	5%
Net Product per hour	126
3—Length of longest cut-2" at 4" per min (fin. bore 2 dia. holes)	.50 min.
Index	.05 min.
Total time of cycle	.55 min.
Oper. handling time	.20 min.
Idle time of operator	.35 min.
Gross hourly product	109
% tool allowance	10%
Net hourly product	98
4—Secure pc. on water test fixture	.08 min.
Turn on water and test pc.	.18 min.
Turn off water and drain	.05 min.
Remove pc. to box	.04 min.
Total Actual Time	.35 min.
Gross hourly product	171
% operator allowance	5%
Net hourly product	162
5—Secure pc. in jig	.10 min.
Pos. to drill	.02 min.
Drill (1) 21/64" hole-½" deep	.07 min.
Pos. for 2nd hole	.04 min.
Drill (1) 21/64" hole-½" deep	.07 min.
Pos. to next spdle.-Open jig	.06 min.
Drill (1) ⅛" hole thru 21/64"-¼" deep	.05 min.
Pos. for 2nd hole	.03 min.
Drill (1) ⅛" hole in 21/64" hole	.05 min.
Pos. work to tap spindle	.04 min.
Tap (1) ⅛" pipe hole	.05 min.
Pos. for 2nd hole	.03 min.
Tap (1) ⅛" pipe hole	.05 min.
Remove pc. to box	.06 min.
Total	.72 min.
Oper. allowance	10%
Gross hourly product	83
Net hourly product	75

With this information at hand, the next step is to set up an operation cycle for the operator who is running the New Britain on the first operation.

"See page 6 for important next meeting announcement."

First, the layout is checked, and it is found that the operations are arranged in a single progressive line. This is not always the most desirable layout for utilizing an operator's idle time, but space often makes this type of layout necessary.

Operation #1 shows a net production of 63 pcs. per hour and a waiting time of .67 min. per cycle. Operation #2 shows that it is capable of producing 126 pcs. per hour and only requires .15 min. of the operator's time of .67 available from operation #1. Therefore, operation #2 is listed in cycle of operation #2. The operator still has .52 min. available time, so we consider operation #3. Here we find .20 min. consumed by actual handling so we add operation #3 to the cycle. The operator must walk approximately 12' each way or 24' in all to complete the triple machine cycle. This will require .12 min. Operation #3 handling time of .20 min. plus walking time .12 equals .32 min., which leaves the operator .20 min. which is not enough to enable him to handle operation #4. He will require another .05 min. to get his next pc. ready on the 1st operation which will leave him .15 min. margin on the cycle.

Therefore, we consider operations 1-2-3 as a cycle for the first operator who should produce 62 pcs. per hour thru these 3 operations. The operator receives 72¢ per hour base rate. We allow an extra 10% for incentive purposes which makes the base hourly rate $.792, which gives us the rate of $.01257 per pc, at 63 pcs. per hour.

Operation #4 and 5 are individual manual operations which are standardized at 162 and 75 pcs. per hour respectively. The same rate per hr. is used, giving a cost per pc. on these operations of $.00495 and $.01056.

The total cost of the pc. for the 5 operations is then totaled, viz.: $.01257—Operation 1-2-3
.00495—Operation 4
.01056—Operation 5

$.02808—Total

This cost is then submitted to the foreman and possibly the division superintendent for his O. K. and becomes the standard direct labor cost of the part.

Incidentally, this same part cost $.09 to machine before 1929 when screw machines were used instead of New Britain Chucking Machines.

HELP WANTED

(All replies will be treated confidentially and must be addressed to the Secretary.)

Widely experienced tool man for special analytical research duty. Must have education and good personality. Boring and cutting experience with diamonds on newest metals required.

Chief Tool Designer, for complete charge of tool and die design department. Should have light stamping and some die-casting experience. Must understand tool building and tryout and possess personality to cooperate with other departments.

(In the past few months between twenty and twenty-five positions of the type indicated above have been filled by the Society.)

BORING BAR SUPPORTING MEANS

by

CHARLES F. STAPLES*

SOME mechanics are of the opinion that the success of a boring bar is in the cutter or boring head; while others claim that the bar itself has everything to do with the success or failure of the boring operation. And still others think that the means of supporting the bar and work determines the degree of successful operation of any boring bar.

This article deals with the method of supporting boring bars and leaves the cutters and bars for a future discussion.

Probably the earliest bars and surely the simplest is shown in Fig. 1, in which a bar is supported in the turret of a screw machine or on the cross slide of a lathe. In either case the work revolves and the finished hole is as good as the machine spindle and the means of holding, disregarding the spring of the bar.

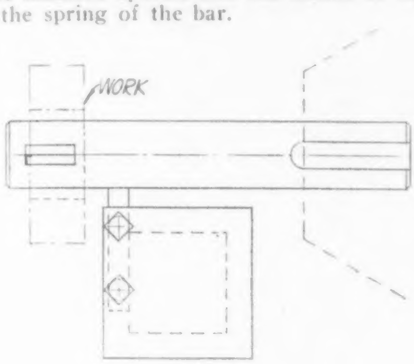


Fig. 1

A bar of this type should be supported up close to the work as shown, by a flat-nosed tool bit supported in the cross slide turret. This little kink is not generally used, but will stiffen a boring bar very much. This method of support can be applied to a two-lip drill for drilling into a cored hole on the turret or engine lathe. When centering, the support can be used against the center drill very successfully. In this case the drill or center-drill actually becomes a boring tool.

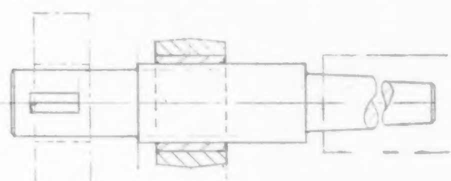


Fig. 2

Fig. 2 needs very little explanation, except to say that the bar which is supported in the machine spindle also has a plain bushing support close to the work. This bar and bushing should be watched closely as wear very soon affects the quality of the work. A few thousandths wear in the bushing or on the bar may result in several thousandths variation in the work.

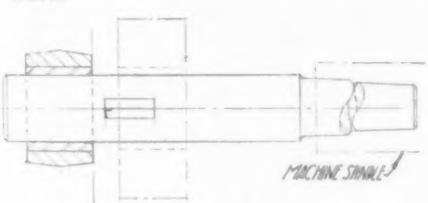


Fig. 3

Fig. 3, is a better way to support the bar as the error is not increased as in Fig. 2, and this construction should be used in preference to Fig. 2 when possible. In Fig. 3 the bar is dependent on the machine spindle for one support.

*Engineer, Jig Bushing Co., Pontiac, Mich.

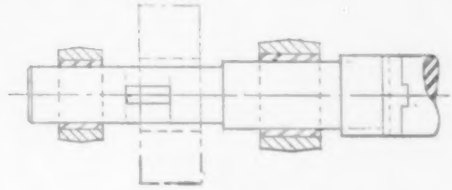


Fig. 4

In Fig. 4 the bar is supported both sides of the work. In this case accuracy is not dependent upon the machine spindle, but is entirely up to the fixture or holding and clamping method of supporting the work, plus the wear and clearance necessary for a running fit between the bar and bushings. In using a set-up of this type, always allow clearance between the bar and bushings. Otherwise expansion and chips are likely to cause the bar to seize in the bushings with expensive results.

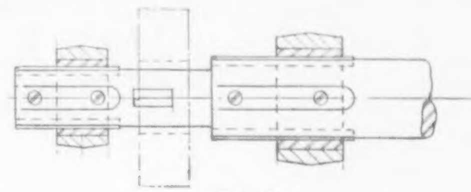


Fig. 5

Fig. 5, is very similar to Fig. 4, except for the renewable wear strips on the bar pilots. This is a more expensive installation than any of the previous examples but is far superior for long runs where accuracy must be maintained. When accurate work is required or when tungsten carbide tools are used, this type may be set up with little or no clearance between the O.D. of the bar and the I.D. of the bushing provided a good supply of coolant is flooded over the bars while they are running. The coolant or lubricating oil should be strained and filtered when the bar is set up without clearance and run at high speeds. This is expensive, but is necessary in order to prevent the bar from freezing when made without clearance.

The wear strips on this bar should be made of bearing bronze and the bushings hardened, ground, and lapped steel. Also, the lead edge of the wear strips should be left sharp to prevent foreign matter working between them and the bushing.

Like all the previous methods shown, this is also highly subject to wear and requires periodic inspection, and check-up to catch any wear which may affect the work produced.

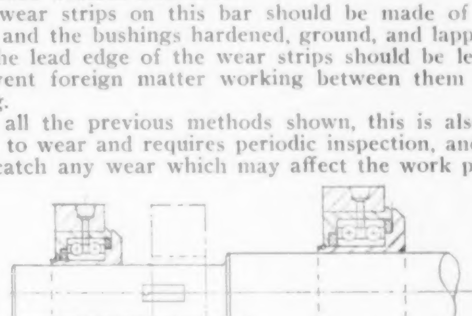


Fig. 6

The supporting method shown in Fig. 6, overcomes the objections met in the previous examples and provides an ideal boring set-up for close accurate work and low maintainence cost. In this set-up a ball-bearing assembly takes care of the load and, as it is protected from dirt and cuttings, it will give long uninterrupted service. Also, roughing and finishing cuts may be taken at the same time, and the finishing cut held to limits of one-ten thousandth for diameter and straight.

A preloaded ball bearing is used and the bar which slides in the two inner bushings is ground to the same size as the I. D. of the bushings. Thus, a set-up is secured that is free of back-lash and clearance, and will produce straight, round, and smooth holes with a minimum of care and attention. This bar may be run at high speed and is especially adapted for diamond boring or tungsten carbide tipped tools.

"See page 6 for important next meeting announcement."

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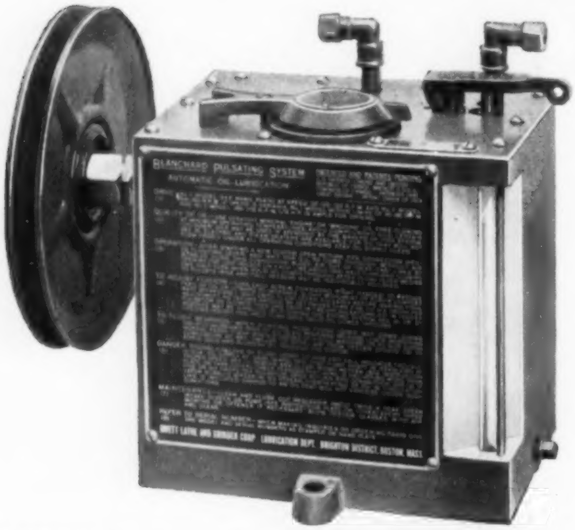

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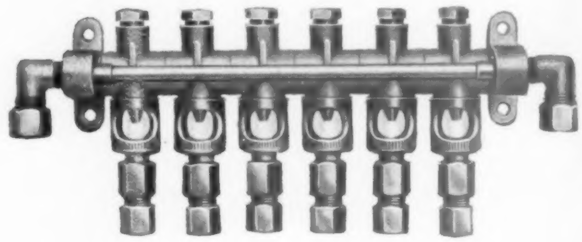

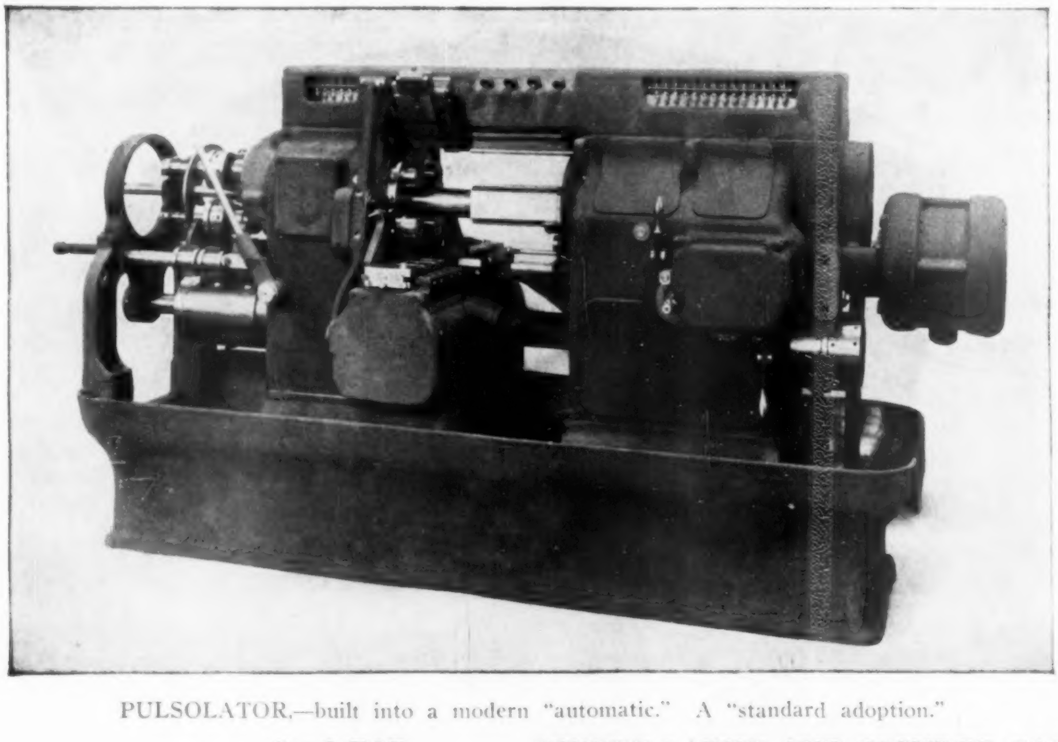

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TECHNICAL

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STRENGTH OF MATERIALS

TORSION IN SHAFTS

BY

W. J. McKEEN

ALL mechanical handbooks contain tables giving the strength of various diameters of shafting. Problems arise outside the scope of these tables and it becomes necessary for the designer to have a method which he thoroughly understands to be applied easily and quickly in such cases. The following method has been found to be useful in such cases and will be presented in the simplest possible manner.

When a rotating shaft is used to transmit its power of rotation to another shaft or to lift weights it is possible that it may rotate without bending. If this is the case the only stress to which the shaft is subjected is **shear.** If the shaft is bent at the time it is being acted upon by a belt or a gear to cause it to rotate it is subjected to shear, **tension,** and **compression.** Stating this another way, if a shaft is twisted only, the only stress set up in the shaft is shear. In this article we shall consider shafts which are subjected to twisting or torsion only.

The measure of the force tending to twist a shaft is called its **twisting moment.** Moments are usually expressed in inch-pounds and are obtained by multiplying a force in pounds by a distance in inches. This is illustrated in Fig. 1 where a weight of one pound is suspended from a pulley having a radius of 2 inches. The twisting moment in this case is the product of 2 inches and one pound, or 2 in-lb.

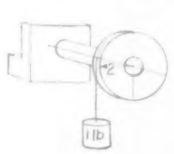

Fig. 1

The fibers of steel in a shaft stretch along its length in a manner similar to the way the strands of a rope extend from its end to the other. When a shaft is twisted each of these minute fibers is resisting a tendency to shear. This is illustrated in Fig. 2.

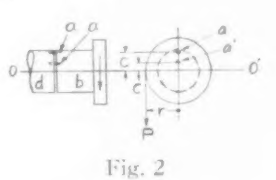

Fig. 2

The two shafts d and b in Fig. 2 are concentric about the center line O—O', and are independent of one another except for the action of the two pins a and a' which extend from one shaft into the other. Consider that shaft d is held in a vice and that a weight, P, is suspended from the large diameter of the shaft b as shown. The twisting moment due to the weight P acting at the radius r, is Pr, —the product of the weight and its distance from the center of rotation. This moment indicates the tendency to shear to which the two pins are subjected.

If only the pin a is used as a means of driving one shaft with the other, the twisting moment required to shear the pin is the area of its cross section in inches times its ultimate shearing strength in pounds per square inch multiplied by its distance from the center of rotation O—O'.

Assume the pin to be made of steel whose ultimate shearing strength is 70,000 pounds per square inch. Assume its area to be .010 sq. in., and that its distance C from the center line is 2". The number of inch-pounds of twisting moment (Torque) shaft d could transmit to shaft b would be 70,000 x .010 x 2 = 14,000 inch-pounds. If we assume r to be 10", then the force P can be found by dividing the 14,000 inch-pounds by 10, which gives a value to P of 1400 pounds.

If we consider the pin a in the preceding example to be one fiber on the inside of a shaft, then we have determined the stresses to which one fiber is subjected. If we consider that both pins take the load then the moment necessary to shear them is the product of each of their cross sectional areas, respective radii, and ultimate shearing strengths.

Let us now consider the number of pins as being increased until the whole cross sectional area of the shaft is made up of an infinite number of microscopically small pins, and we have a picture of a shaft composed of fibers,—each pin being a fiber.

The shearing stress in each fiber is proportional to its distance from the center of rotation. The shearing stress of each fiber times its distance from the axis would be impossible to obtain by measurements. By the use of Calculus a formula has been developed which anyone can use even though he knows no Calculus. The formula gives a quantity known as the **polar moment of inertia,** which in a sense indicates the sum of the products of the areas of all the fibers and the square of their respective distances from the center of rotation. The polar moment of inertia of round shafts can be found by using the following formula:

$$\text{Polar Moment of Inertia} = \frac{3.1416\ (\text{Diameter of Shaft})^4}{32}$$

The total twisting moment a shaft san withstand (External Twisting Moment) can be found by using the following formula:

$$\text{External Twisting Moment} = \frac{(\text{Ultimate Shearing Strength})(\text{Polar Moment of Inertia})}{(\text{Factor of Safety})(\text{Radius of Shaft})}$$

The following example will indicate how the formula is to be used: What pressure at the pitch line of a 10" diameter gear can a 2" diameter shaft deliver if its ultimae shearing strength is 70,000 pounds per square inch and a factor of safety of 20 is used?

Using the first formula,

$$\text{Polar Moment of Inertia} = \frac{3.1416 \times 2^4}{32} = 1.571.$$

Using the second formula,

$$\text{External Twisting Moment} = \frac{70{,}000 \times 1.571}{20 \times 1} = 5498.5 \text{ in.-pounds.}$$

To find the pressure at the pitch line we divide 5489.5 inch-pounds by the pitch radius of the gear, 5", and obtain 1099.7 pounds as the pitch line load. This load in pounds corresponds to the pull P in Fig. 2.

(Continued next issue.)

"See page 6 for important next meeting announcement."